WADC TECHNICAL REPORT 54-18

SEALING OF SYNTHETIC SAPPHIRE TO GLASS

EMIL BENZ
ELECTRONIC COMPONENTS LABORATORY

JANUARY 1954

WRIGHT AIR DEVELOPMENT CENTER

NOTICES

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The information furnished herewith is made available for study upon the understanding that the Government's proprietary interests in and relating thereto shall not be impaired. It is desired that the Judge Advocate (WCJ), Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, be promptly notified of any apparent conflict between the Government's proprietary interests and those of others.

WADC TECHNICAL REPORT 54-18

SEALING OF SYNTHETIC SAPPHIRE TO GLASS

Emil Benz
Electronic Components Laboratory

January 1954

RDO No. 111-101

Wright Air Development Center
Air Research and Development Command
United States Air Forces
Wright-Patterson Air Force Base, Ohio

FOREWORD

This report was initiated by the Electronic Components Laboratory, Directorate of Research, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. Work was accomplished under RDO No. 111-101, GENERAL INVESTIGATION OF ELECTRON TUBES, with Mr. Leo L. Gibbs as the project engineer. Mr. Emil Benz was in charge of the task under this RDO.

ABSTRACT

A new method of sealing synthetic sapphire to glass by using an electric arc is described. Its advantages and applications are analyzed.

PUBLICATION REVIEW

The publication of this report does not constitute approval by the Air Force of the findings or the conclusions contained therein. It is published only for the exchange and stimulation of ideas.

FOR THE COMMANDER:

R. E. Long

RICHARD S. CARTER
Colonel, USAF
Chief, Electronic Components
Laboratory
Directorate of Research

GENERAL

Sealing synthetic sapphire to glass is widely used as in infrared detecting cells, disks or windows in wave guides, or high frequency power tubes. Up to now, the sealing process (AF Technical Report No. 6495, MAKING AND SEALING SYNTHETIC SAPPHIRE WINDOWS TO INFRARED DETECTING CELLS) could be performed only by highly skilled glass blowers. The procedure was cumbersome and the risk of damaging the expensive sapphire disks was high.

The new sealing method here described is speedier and can be used by unskilled personnel. The process can be better controlled, resulting in more uniform sealing. This is an important improvement for mass production.

DESCRIPTION OF ARRANGEMENT

Let us assume, as an example, that a flat sapphire disk is to be sealed to a glass tube. Corning Glass No. 751, as described in AF Technical Report No. 6495, is to be used as sealing glass. The tube with the sapphire disk on top, both of approximately the same diameter, is placed in the chuck of a vertical glass lathe and connected to a swivel joint, from which a side arm leads to a vacuum pump (Fig. 1). A pressure difference of about 20 millimeters is required to avoid displacement of the disk during the sealing operation. An electric furnace above the tube (Fig. 1) preheats the sealing area.

Two opposite graphite rods in horizontal position point to the area to be sealed. Between the rod tips and the outer edge of the glass-sapphire connection is a distance of about 1/32 inch. The furnace is located approximately one inch above the graphite rods.

A high voltage transformer, regulated by a variac, provides an arc discharge between the graphite rods and the glass-sapphire combination. By raising or lowering the sealing area, it can be moved into the furnace or between the two graphite rods. Figure 2 is a photograph of the equipment.

SEALING OPERATION

The glass tube, with sapphire disk on top, is rotated slowly at about 40 rpm, while a holding vacuum is applied. The sealing area is preheated in the furnace to about 500°C, then lowered into position between the graphite rods. The voltage is turned on immediately for three to four seconds, and the sealing is performed. The vacuum is then released, and the sealed tube can be raised for annealing in the overhead furnace or placed in an annealing oven.

The distance of the graphite rods from the sealing oven and the disk diameter determine the arc voltage to be used. For sealing 1/2-inch disks, 15,000 volts are adequate. This power should be supplied by a high impedance source.

Sealing disks two of each in sizes 1/4 inch, 1/2 inch, and 5/8 inch in diameter were manufactured and tested as follows (Fig. 3):

1. Preheated to 400°C.
2. Dipped into boiling water, then into cold water.
3. Dipped into liquid nitrogen followed by exposure to room temperature.
4. Checked for leakage with a leak detector.

The disks showed no failures by this test procedure. Synthetic sapphire can be sealed to any kind of glass or metal tubing by using graded seals.

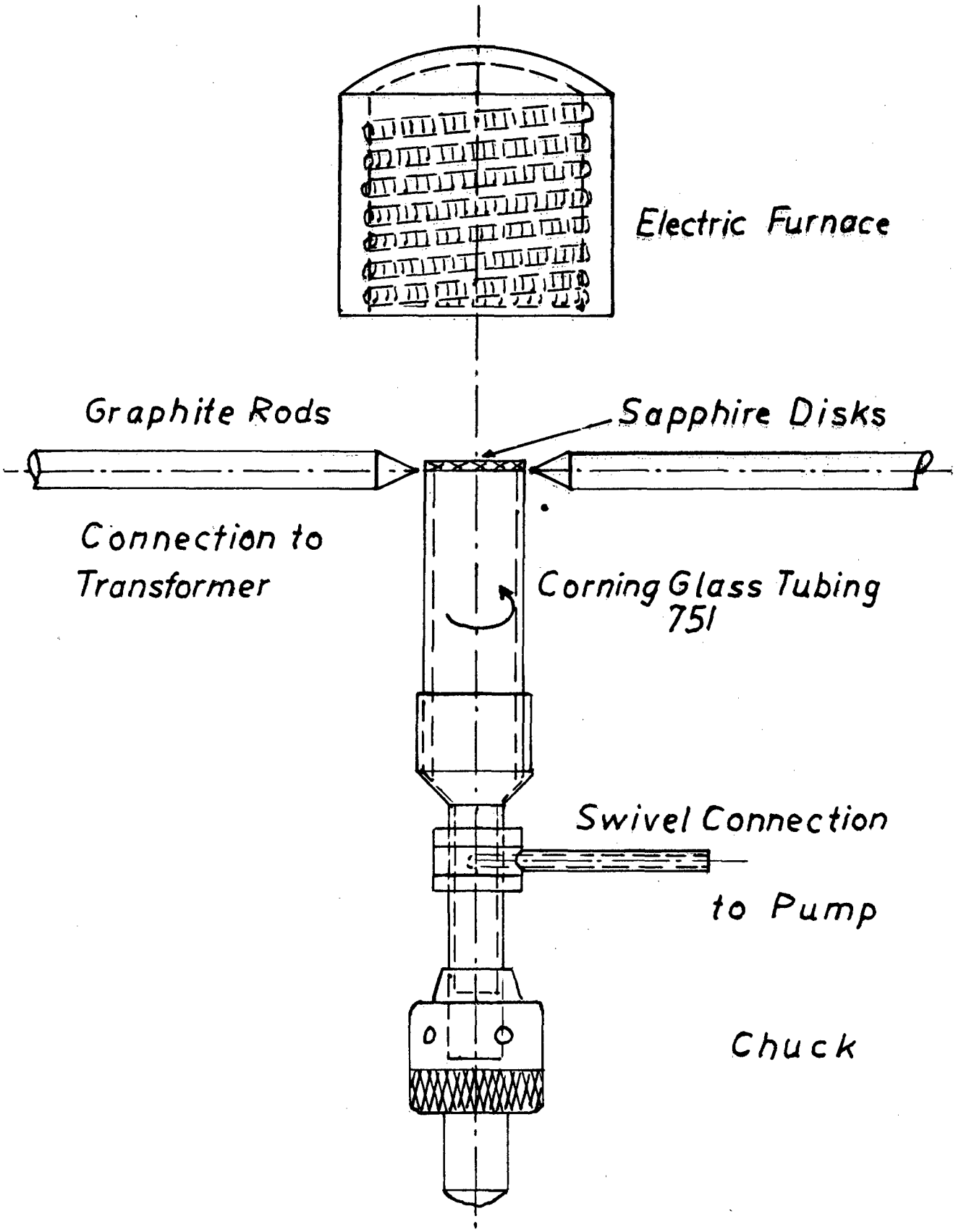

Fig. 1 - Diagram of Sealing Arrangement

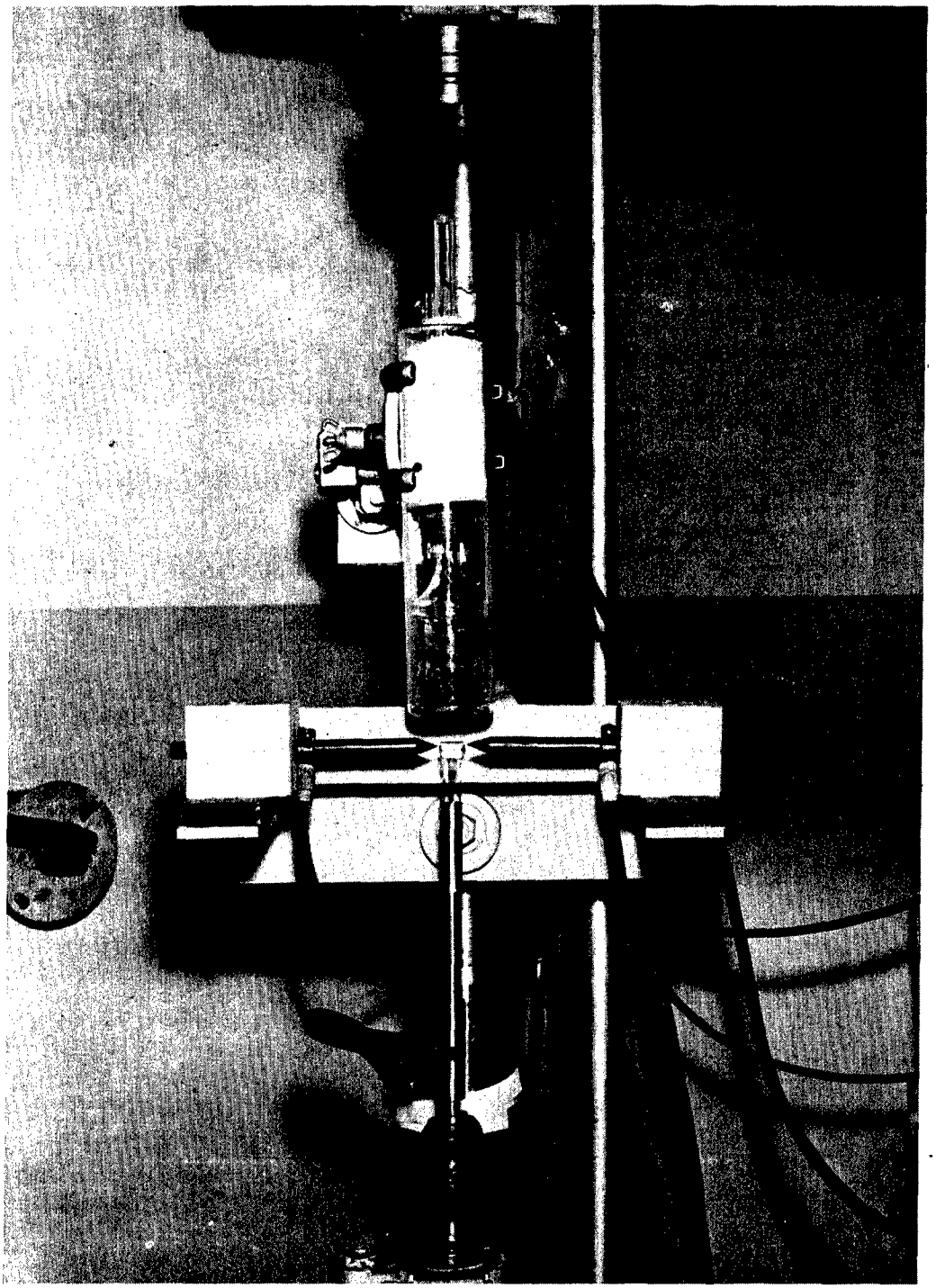

Fig. 2 - Glass Lathe Arrangement for Sealing

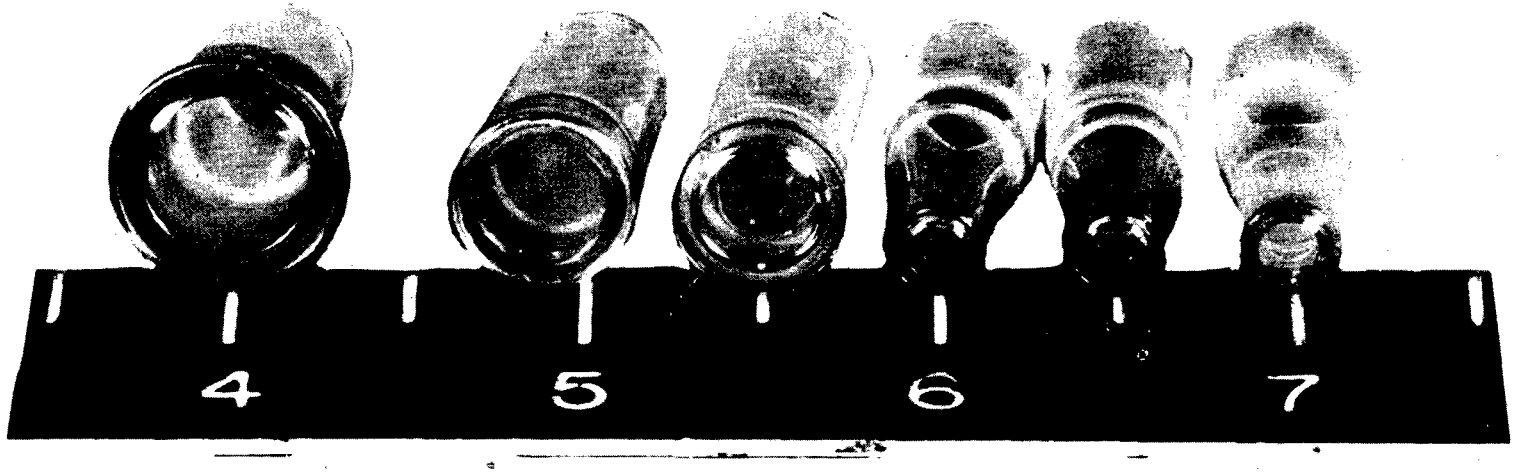

Fig. 3 - Three Sizes of Synthetic Sapphire Sealed to Glass

DISTRIBUTION LIST

Copies	Activities at Wright-Patterson Air Force Base
5	DSC-SA
2	WCAPP
10	WCREO-2
3	WCLRO
1	WCLNO
2	WCLGB (Attn: Dr. Null)
2	WCRRH (Attn: Dr. Clemens)
2	WCRDF (Attn: Dr. Heim)
1	WCRTO
1	WCSPP (for transmittal to Rand Corp.)
1	WCHV (for transmittal to the Office of Technical Services, Department of Commerce, Washington 25, D. C.)

Copies	Other Department of Defense Agencies
1	Commander AF Cambridge Research Center Attn: Electronics Research Library, CRTSL-1 230 Albany Street Cambridge 39, Massachusetts
1	Commander Rome Air Development Center Attn: Research Library, RCRES-4C Rome, New York
1	Commander AF Missile Test Center Patrick Air Force Base Cocoa, Florida
1	Commander Air University Library Maxwell Air Force Base, Alabama
1	Chief Bureau of Ships Code 816 Navy Department Washington 25 D. C.
1	Chief Bureau of Aeronautics Electronics Division Material Coordination Unit Navy Department Washington 25, D. C.
1	Chief Bureau of Aeronautics Attn: Technical Data Division, TD-412 Navy Department Washington 25, D. C.
1	Commander Redstone Arsenal Attn: Technical Library, GMDD, MGG Huntsville, Alabama
1	Commanding General Signal Corps Engineering Labs. Attn: Technical Documents Center Evans Signal Lab Area, Bldg.27 Belmar, New Jersey
1	U. S. Navy Electronics Laboratory Attn: A. H. Attebury, Code 733 San Diego 52, California

Copies	Miscellaneous
1	National Bureau of Standards Div 13.1 Miniaturization Laboratory Attn: Gustave Shapiro Washington 25, D. C.